

UNITED STATES PATENT APPLICATION

of

Kenneth S. Morley

and

Scott M. Christensen

for

**CONNECTOR SCHEME TO ALLOW PHYSICAL
ORIENTATION OF A COMPUTER PERIPHERAL**

WORKMAN, NYDEGGER & SEELEY
A PROFESSIONAL CORPORATION
ATTORNEYS AT LAW
1000 EAGLE GATE TOWER
60 EAST SOUTH TEMPLE

005050-80735960

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to adaptor structures selectively coupled to an interface on a digital device. More specifically, the present invention applies to an adaptor for directly coupling to a peripheral device and selectively coupling to a digital device regardless of the digital device's interface orientation or position.

Description of Related Art

Adding an old-fashioned peripheral device to a digital device, such as a personal computer, can be a very difficult process. The user is often required not only to have considerable computer expertise, but also a certain amount of providence. First, the user must determine which port from a vast assortment of possibilities on the digital device to use. Then in most cases, the user must open the digital device to install a peripheral device controller card and set various DIP switches. Finally, the user must properly configure the touchy IRQ settings, not to mention other machine specific alterations. This process was almost enough to deter even the most resourceful users from even thinking about adding a new peripheral to their digital device.

The industry recognizes that standardization of peripheral device interfaces, among other things, greatly increases the demand for peripheral devices and as such the industry has developed a wide variety of standard peripheral device interfaces. The most common of these peripheral device interfaces are serial ports and parallel ports. Unfortunately, as computer processor speeds and user performance expectations continue to increase, it is apparent that the older and traditional peripheral device interfaces no longer communicate at fast enough rates for the modern peripherals.

1 In view of the configuration hassles previously associated with customized
2 peripheral device interfaces and the speed and bandwidth limitations of available
3 standardized peripheral device interfaces, several manufacturers collaborated to develop
4 the Universal Serial Bus (USB) specification. USB connects computers and peripherals.
5 USB devices provide a user with an easy, compact device that can connect to most digital
6 devices. The speed ranges of the USB peripheral-to-PC connection are 480 Mbits/s on
7 USB 2.0, 12 Mbits/s on USB 1.1, and 1.5 Mbits/s on USB 1.0. The higher bandwidth of
8 USB peripheral device interfaces allow for support of applications, such as wireless
9 networking, digital image creation, and web publishing.

10 Now, many electronic devices being manufactured, especially those requiring an
11 instant, no-hassle, high-speed connection are adapted to accommodate these standards.
12 Digital photography, digital imaging, PC-telephony, and video conferencing, in
13 particular, are increasingly popular for both business and personal applications due in
14 part to the development of USB compatible peripheral devices designed to increase the
15 functionality of the computers in these areas. As an example, USB devices are commonly
16 used to provide added features and/or functions. For instance, USB allows quick
17 connections for a new digital joystick, a scanner, a set of digital speakers, a digital
18 camera, a PC telephone to the computer, or other USB device supplying add-on
19 functionality.

20 The USB specification also developed and promulgated standards for the physical
21 design, dimensions, and electrical interface of peripheral devices using a keyed connector
22 protocol. Specifically, the USB standard identifies two primary connector types: Series
23 A and B. These connector types correspond to physical dimension restrictions that insure
24 proper end user connectivity. Series "A" connectors are the principle means of

1 connecting USB devices directly to a host computer system or to the downstream port of
2 a hub. The series "A" receptacles provide a downstream output interface from the USB
3 host system or hub. The series "A" plugs electrically and mechanically couple with the
4 series "A" receptacles such that the plugs are always oriented upstream towards the host
5 system. The series "B" connectors are used as one available means of connecting a USB
6 cable to the peripheral device and allowing peripheral device vendors to provide the user
7 with a standard detachable cable for use with their device. As such the series "B" plug is
8 always oriented downstream towards the USB device and series "B" receptacle.
9 Unfortunately, both types of connectors have a fixed orientation with respect to the
10 receptacles for receiving the plugs on the host and peripheral device.

11 Currently, USB series "A" receptacles can be found on current notebook
12 computers in all of the four possible 90-degree orientations. One common problem
13 presently faced by many USB peripheral devices is how to attach a peripheral, which
14 requires a specific orientation, via a USB plug to a USB receptacle in each of the possible
15 orientations without using multiple joints or a cable to reorient the peripheral. Other
16 industry attempts to solve this problem require either an attached cable or multiple joints.
17 Unfortunately, the attached cable solution does not allow direct connection to the
18 computer, as a finite length of cable is necessary before it can reorient the peripheral, and
19 thus the cable retains a residual amount of rotational tension. The use of multiple joints
20 is also undesirable as these connections are expensive and not reliable. It would be an
21 advance over the present state of the art to develop an adaptor that maintained all of the
22 USB functionality, but improved the ability of the adaptor to reorient an interface for the
23 attached peripheral thereby increasing the functionality and control of the attached
24 peripheral.

1 Exemplary USB peripheral devices that require specific orientation include short-
2 range wireless devices and USB antenna structures. Antenna structures, predominantly
3 used for wireless communication, efficiently transmit and receive electromagnetic energy
4 in the form of radio waves. Antenna structures are used whenever it is impractical, or
5 impossible to use a physical connection, such as a transmission line or wave-guide. In
6 order to get the best performance out of a wireless antenna, the antenna must not be
7 obstructed by anything within its path of radiation. Conventional antennas used to
8 connect a digital device to a wireless communication system or cellular telephone are
9 typically placed externally from the digital device because of the noise, interference,
10 obstruction and shielding caused by the various components of the digital device. In
11 particular, conventional antennas do not function correctly if they are obstructed or
12 shielded by the housing or other structures of the digital device. As such USB antenna
13 structures, if properly oriented, can avoid many of the aforementioned problems.
14 Additionally, USB antennas are externally located, typically have high bandwidth
15 capabilities, and are selectively detachable from the USB receptacle. However, the use of
16 multiple joints or a cable hinders the performance of the USB antenna by reducing the
17 available power for radiation. The use of easy attachment and configuration USB
18 antennas are good for the progress and integration of wireless communication.

19 One short-range wireless standard that is in the process of being embraced is
20 preliminarily known by the name of "Bluetooth." Bluetooth, which is only one example
21 of a short-range wireless standard, is actually a combination of specialized computer
22 chips and software. Bluetooth is the codename for a technology specification for small
23 form factor, low-cost, short-range radio links between mobile PDAs, PCs, mobile phones
24 and other portable devices. Bluetooth, for example, also offers speedy transmission of up

1 to one megabyte per second, over 17 times as fast as a typical modem. One of the present
2 Bluetooth specification restrictions is to limit the transmission range so that the resulting
3 radiation pattern typically does not exceed 10 meters.

4 The IEEE 802.11 RF wireless standards: 802.11 HR, 802.11b, and 802.11 @ 5
5 GHz standards are also very popular. Other exemplary short-range wireless standards
6 potentially useful with USB antenna structures include: HiperLan, HiperLan II, HomeRF,
7 SWAP, OpenAir, and other wireless protocols. These wireless standards enable users to
8 connect a wide range of computing and telecommunications devices easily and simply,
9 without the need to buy, carry, or connect cables. They deliver opportunities for rapid ad
10 hoc connections, and the possibility of automatic, unconscious, connections between
11 devices. They may virtually eliminate the need to purchase additional or proprietary
12 cabling to connect individual devices. Because these standards can be used for a variety
13 of purposes, they will also potentially replace multiple cable connections via a single
14 radio link. If properly oriented USB antenna structures can greatly improve the
15 development and integration of these standards into a home computer thereby facilitating
16 a wireless computing environment.

The present invention creates a communication quality connection across an interface between a digital device and a peripheral device, while enabling the flexible orientation of the peripheral device relative to the interface. These qualities are primarily accomplished through an adaptor, which includes two connectors one for coupling to the digital device and a second connector for coupling to the peripheral device. The adaptor electrically extends the interface signals to the second connector, which facilitates peripheral orientation.

The present invention has been developed in response to the current state of the art, and in particular, in response to these and other problems and needs that have not been fully or completely solved by currently available connectors for peripheral devices. Thus, it is an overall object of the present invention to provide a reliable reorienting connection between the attached peripheral device and the digital device via a custom adaptor. This can be accomplished by having the adaptor attached to the peripheral device via a custom connector assembly, which can connect to the peripheral in any of the different orientations. The peripheral connector on the adaptor is wired to insure proper connection of the signals in all possible orientations. In one embodiment, a USB series “A” plug delivers the 4 USB signals to the custom connector assembly, which facilitates connection between the adaptor and the peripheral device in four different orientations. An example of the pin configuration used with this connector assembly is shown in Figure 3.

Accordingly, one aspect of the apparatus is to provide a simple, reliable, and low cost solution to directly connecting the peripheral to the USB connector receptacle while

1 maintaining a desired peripheral orientation. Other solutions, which may be available,
2 compromise one of these elements.

3 Another aspect of the apparatus is that the adaptor provides a custom peripheral
4 connector, which can connect to the peripheral device in different orientations without
5 changing the peripheral connector. The custom peripheral connector on the adaptor is
6 electrically wired in such a way so as to insure proper connection of the signals in all
7 possible peripheral device orientations.

8 Yet another aspect of the apparatus is to create a USB compatible short-range
9 wireless (e.g. "Bluetooth", 802.11 RF, etc.) interface device that properly orients the
10 antenna and maintains all of the traditional wireless functionality. The USB connection
11 improves the connection speed between the peripheral and host computer, thereby
12 improving the overall wireless connections available.

13 Additional objects and advantages of the invention will be set forth in the
14 description which follows, and in part will be obvious from the description, or may be
15 learned by the practice of the invention. The objects and advantages of the invention may
16 be realized and obtained by means of the instruments and combinations particularly
17 pointed out in the appended claims. These and other objects and features of the present
18 invention will become more fully apparent from the following description and appended
19 claims, or may be learned by the practice of the invention as set forth hereinafter.

In order that the manner in which the above recited and other advantages and objects of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof, which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

Figure 2 is a perspective view of a custom connector interface for rigidly affixing an adaptor and peripheral in one of four orientations, the coupled combination for use with a digital device as illustrated in Figure 1;

Figure 4 is a perspective view of a circular contact connector interface for rigidly affixing a rotating adaptor and peripheral together;

Figure 6 illustrates a side view of a custom connector for use with a four contact connector.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 and the following discussion are intended to provide a brief, general description of a suitable computing environment in which the invention may be implemented. Those skilled in the art will appreciate that the invention may be practiced with many types of computer system configurations, including personal computers, hand-held devices, multi-processor systems, microprocessor-based or programmable consumer electronics, network PCs, minicomputers, mainframe computers, Personal Digital Assistants, digital cameras, and the like.

Reference is first made to Figure 1, an exemplary laptop computer system or environment in which the present invention may be utilized or implemented. Figure 1 is intended to be illustrative of potential systems that may utilize the present invention and is not to be construed as limiting. The system of Figure 1 illustrates a portable computer 10 having a pair of universal serial bus (USB) series "A" connector receptacles 12 that are each configured to receive a USB series "A" plug 22. The USB receptacles having a rectangular shield shell that aligns with the shield shell of the USB plug so that the receptacle VBUS 14, D- 16, D+ 18, and GND 20 signal contacts interface with the plug VBUS 15, D- 17, D+ 19, and GND 21 signal contacts. These signals are replicated in adaptor 24 to generate a 16-pin custom adaptor interface 26 (described in more detail under Figure 3). The adaptor interface electrically and mechanically couples with 16-pin peripheral interface 28 on peripheral device 30.

The connector receptacle 12 preferably defines a cavity that receives a portion of the connector plug 22. The receptacle 12 is preferably shaped so as to preclude insertion of electrically incompatible connector plugs. This feature prevents the inadvertent attachment of plugs that contain electrical signals that could damage electronics within

1 the attached peripheral device. This feature also precludes insertion of inverted
2 connector plugs. The connector receptacle 12 further comprising a retention mechanism,
3 and the force imposed thereby, provides tactile and audible feedback to notify the user
4 when the connector plug 22 has been securely received within connector receptacle 12.
5 The connector receptacle 12 and retention mechanism is fashioned to mechanically fasten
6 the connector plug 22 in the proper place. The USB connector receptacles are generally
7 configured to removably receive a USB connector plug that is connected to one end of a
8 USB cable. There are three supported USB adaptor assemblies for interfacing with a
9 USB connector receptacle: a standard detached cable, a high or full speed captive cable,
10 and a low speed captive cable. In one preferred embodiment, adaptor assembly 24 is
11 either a high, full, or low speed series "A" plug captive cable configuration without a
12 cable. The term "captive cable" means that the adaptor 24 is terminated on one end by a
13 series "A" plug and on the opposite end by a vendor specific connection means
14 (hardwired or custom detachable) for use with the peripheral device. One difference
15 between the various cable assemblies and the present invention is the rigid coupling of
16 the peripheral via the adaptor to the USB receptacle. By eliminating the cable between
17 the plugs, the adaptor eliminates the residual rotational tension present in operationally
18 reoriented cable assemblies. Furthermore, the reliability of the adaptor increases over
19 cable assemblies that may crack and wear over time.

20 In contrast, the custom adaptor interface 26 is preferably shaped so as to allow
21 insertion of an inverted peripheral interface 28, as well as any other approved peripheral
22 orientation. In one configuration, the peripheral interface is allowed to continuous
23 reorient itself along a series of circular contacts to optimally arrange the attached
24 peripheral. The custom adaptor interface does, due to its customized design, inhibit the

1 insertion of electrically incompatible connector plugs. This feature hampers the
2 inadvertent attachment of plugs that contain electrical signals that could damage
3 electronics within the computer. The custom adaptor interface 26 further comprises a
4 retention mechanism, and the insertion force imposed thereby, provides tactile and
5 audible feedback to notify the user when the peripheral interface 28 has been securely
6 received within adaptor interface 26. The adaptor interface 26 and retention mechanism
7 are fashioned to mechanically fasten the peripheral interface 28 in the proper place.
8 While the custom adaptor interface 26 also selectively receives a portion of the peripheral
9 interface 28, the extraction force of the adaptor interface and the peripheral interface
10 exceeds the extraction force and insertion force of the connector plug and receptacle. In
11 one configuration, the USB connector plug and receptacle exhibit an insertion force of 35
12 Newtons maximum at a maximum rate of 12.5 mm per minute and an extraction force of
13 10 Newtons minimum at a maximum rate of 12.5 mm per minute. Exceeding the
14 extraction force of the plug and receptacle coupling insures that the adaptor interface and
15 peripheral interface coupling will remain connected when the connector plug is removed
16 from the connector receptacle on the computer. In one configuration, the extraction force
17 of the adaptor interface and peripheral interface coupling is less than the cable pull-out
18 performance of the USB connector, such that the application of a steady state axial load
19 of 40 Newtons for one minute will result in a separation of peripheral interface from
20 adaptor interface. In another configuration, the peripheral and adaptor interface coupling
21 extraction force exceeds even the standard USB cable pullout specification to insure that
22 the peripheral does not separate itself from the adaptor once it is properly oriented.

23 The adaptor 24 couples to peripheral device 30 illustrated as a short-range
24 wireless device. The adaptor 24 may also couple with devices such as a scanner, digital

1 camera, modem, a network hub or interface card, a wireless communication card
2 including antenna, an external device controller card, or any other USB compatible
3 peripheral device. The USB plug 22 of adaptor 24 is configured to detachably connect
4 with a high-speed USB connector receptacle 12. The transfer rates of the USB
5 peripheral-to-PC connections vary according to the USB version employed by the
6 peripheral device. Presently there are three existing USB data transfer rates: High speed
7 (480 Mbits/s using USB 2.0 or better), Full speed (12 Mbits/s using USB 1.1), and Low
8 speed (1.5 Mbits/s using USB 1.0 or less). High and Full speeds require a shielded cable
9 with two power conductors and a twisted pair of signal conductors. The higher
10 bandwidth of USB peripheral device interfaces when compared to tradition serial and
11 parallel port transfers allow for support of applications, such as wireless networking,
12 digital image creation, and web publishing.

13 Inserting USB plug 22 in USB receptacle 12 permits adaptor 24 to be in electrical
14 and physical communication with computer 10. In one preferred configuration,
15 receptacle 12, plug 22, and adaptor 24 are USB compliant. As such, the USB connectors
16 are designed to be hot plugged. Series "A" plugs mate with series "A" receptacles. The
17 series "A" plug always is oriented toward the host system. Electrically, series "A"
18 receptacles function as outputs from host systems and/or hubs. The adaptor 24
19 transfigures the four USB contacts of the standard USB connector, consisting of two
20 power conductors and two signal conductors, into one of the custom connector pin
21 assignments illustrated in Figures 3, 5, and 6. Ground contact 21 provides a common
22 ground reference between the upstream and downstream ports and is replicated in adaptor
23 24 as contacts 42, 42', 42'', and 42''' in Figure 3a. The voltage drop across the ground
24 lead limits the maximum cable length. The VBUS 15 contact is replicated as contacts 36,

1 36', 36'', and 36''' in Figure 3a, it also provides power to the connected peripheral
2 device 30. To satisfy the USB high/full speed captive cable assembly requirements, the
3 adaptor should satisfy the following electrical requirements: First, the adaptor must be
4 terminated on one end with a series "A" plug and on the opposite end with a vendor
5 specific or custom peripheral interface. If the vendor specific interconnect is to be hot
6 plugged, it must meet the same performance requirement as the USB series "A" and "B"
7 connectors. Second, the adaptor must be rated for high speed and full speed. Third, the
8 adaptor impedance must match the impedance of the high speed and full speed drivers.
9 Fourth, the drivers are characterized to drive specific adaptor impedance. The USB
10 specification revision 2.0 § 7.1.1 provides adaptor impedance details. The maximum
11 allowable adaptor replication breadth and length is determined by the signal pair
12 attenuation and propagation delay. Fifth, differences in propagation delay between the
13 two replicated signal conductors 17 and 19 must be minimized. Sixth, the ground contact
14 21 provides a common reference between upstream and down stream ports. The voltage
15 drop across the ground lead limits the maximum adaptor length. The minimum wire
16 gauge used in the adaptor is calculated using the worst-case current consumption. And,
17 finally, the VBUS contact 15 provides power to the peripheral device via replicated
18 contacts. The minimum wire gauge is peripheral specific, but is most preferably the same
19 as the ground contact.

20 In one configuration of the present invention, the raw materials used in the
21 fabrication of the USB to custom adaptor 24 must be of such quality that the fabricated
22 adaptor is capable of moving or exceeding the mechanical and electrical performance
23 criteria of the most current USB specification revision and all input federal domestic and
24

1 international safety/testing agency requirements; such as, UL, CSA, BSA, NEC, etc., for
2 electronic signaling and power distribution cables in this category.

3 Although adaptor 24 includes plug 22, which is illustrated as a USB Series "A"
4 connector plug, the adaptor may also be any connector type, including but not limited to,
5 propriety based multiple pin connectors, 15-pin connectors, RJ type connectors, or
6 coaxial cable connectors. The terms connector receptacle, miniature modular jack,
7 dongle connectors, physical/electrical media connector, fixed jack, AC820 compliant
8 jack, XJACK® connectors or sockets, alligator jack, and the like, connote a media
9 connector that may have qualities such as those connectors having physical attributes
10 described in FCC Part 68, Subpart F. Specific terms such as RJ-type, RJ-11, RJ-45, 6-pin
11 miniature modular plug, 8-pin miniature modular plug, USB series "A" and "B"
12 connectors, and similar terminology are all references to specific exemplary
13 physical/electrical media connectors falling within the broader parameters of the term
14 media connectors and are cited by way of example and should not be used to limit the
15 scope of the present invention to specific connectors. This is particularly true as many of
16 the aforementioned connector sockets do not presently provide variable orientation based
17 coupling as used by the present invention, and the custom adaptor to peripheral interface
18 would require modifications to appropriately practice the invention. Therefore, the
19 connection type is not as important as the ability to make a connection between a digital
20 device and an adaptor, replicate the signals from the digital device and pass them through
21 a custom peripheral interface on the adaptor to a peripheral device. For example, if the
22 digital device is coupled using RJ-type connectors to the adaptor then the RJ signals
23 should be replicated and extended to the custom peripheral interface. Connector signals
24 may need to be reoriented at the adaptor before coupling with the peripheral device for a

1 variety of reasons including improved antenna reception, easier detachment, or operable
2 positioning.

3 Figure 2 is a perspective view of a custom connector interface for rigidly affixing
4 an adaptor and peripheral in one of four orientations. Specifically, Figure 2 illustrates the
5 four different orientations possible for custom adaptor 24 with respect to a USB
6 receptacle and peripheral device 30. The four USB contacts are replicated into four
7 duplicate contacts within adaptor interface 26. Each orientation relies on different contact
8 pins in adaptor interface 26 to actively communicate with peripheral interface 28.
9 Groups of active contacts are illustrated in Figure 3 that correspond to the relative
10 positional orientations of the adaptor interface as illustrated in Figure 2. The various
11 orientations are used to properly orient antenna 32 in the vertical position on peripheral
12 30 relative to the orientation of the USB receptacle. This solution provides a simple,
13 reliable, and low cost solution to directly connect the peripheral to the USB connector
14 receptacle. Other solutions compromise one of these elements.

15 Custom adaptor 24 comprises a USB connector plug 22 and a custom adaptor
16 interface 26 (described in more detail in Figure 3). The adaptor interface 26 may employ
17 various contact configurations that allow for the peripheral 30 to be properly oriented
18 relative to the USB plug 22. Exemplary contact configurations are illustrated in Figures
19 3 and 5. The adaptor interface illustrated in Figure 2 is compatible with the 16-pin
20 custom contact assignment matrix illustrated in Figure 3. In this manner the custom
21 adaptor may be rotated in any one of the four different possible wire orientations so that
22 the peripheral antenna 32 may be attached to the adaptor in a vertical fashion. In this
23 configuration it is preferred that the custom adaptor 24 only be used with one peripheral
24 device and remain oriented specifically for the individual laptop configuration. In other

1 words, it is anticipated that this adaptor will only need to be set once or at least
2 infrequently as peripheral devices are generally not widely shared between different
3 computers. As such, the connection between the peripheral and the custom adaptor is a
4 strong mechanical connection such that if one pulls on the peripheral the USB connector
5 will be the first connection to break and the custom adaptor will remain attached to the
6 peripheral.

7 For illustrative purposes only, peripheral device 30 is a USB short-range wireless
8 module, such as a bluetooth radio, rigidly connected to the USB connector receptacle via
9 adaptor 24. Where the adaptor is designed to operably orient antenna 32 in an upward
10 fashion. In one configuration, peripheral device 30 is a transceiver module electrically
11 connected to the custom peripheral interface 28 and to a short-range wireless antenna 32.

12 Bluetooth, which is only one example of a short-range wireless standard, is
13 actually a combination of specialized computer chips and software that enable small-form
14 factor, low-cost, short-range radio links between laptops, phones, and other portable
15 digital devices. By way of example, peripheral 30 includes all of the necessary hardware
16 components to create the radio link. Specifically, the peripheral bluetooth module
17 incorporates a bluetooth stack, a link manager, a RF baseband radio, and a power
18 amplifier to generate the bluetooth signals. The bluetooth signals are then transmitted to
19 short-range wireless antenna 32. The short-range wireless antenna transceiving the
20 bluetooth signals, with the desired orientation for the short-range wireless antenna being
21 upwards. The standard transfer rate for high-speed bluetooth connections is up to one
22 megabyte per second, over 17 times as fast as a typical modem.

23 Rather than designing the short-range wireless peripheral 30 to have multiple
24 joints or to use a cable assembly to supply reorientation, the illustrated embodiment of

1 the adaptor and peripheral are configured to accommodate all four USB orientations. As
2 such, the user could determine how the USB port on their laptop was oriented and
3 appropriately connect the peripheral 30 and antenna 32. Assuming that the connected
4 USB peripheral is a single user peripheral, the adaptor interface and peripheral interface
5 could be lastingly coupled in the appropriate orientation relative to the users USB
6 connector receptacle.

7 Figure 3a illustrates a 16-pin custom contact assignment matrix for use with the
8 peripheral interface 28 as illustrated in Figure 2. Specifically, the 16-pin custom contact
9 assignment matrix illustrates how the USB input contacts 15, 17, 19, and 21 are
10 replicated and connected to respective contacts A 36, B 38, C 40, and D 42 in the contact
11 assignment matrix. The adaptor interface on the module is wired in such a way so as to
12 ensure the proper connection of the four USB signal lines in each of the possible
13 orientations of the adaptor interface. The active contacts for each orientation are grouped
14 together. For example, if adaptor 24 is properly oriented then adaptor interface 26
15 includes the active contacts 36, 38, 40, and 42. When the adaptor is rotated 90-degrees
16 the active adaptor interface is 26' includes contacts 36', 38', 40', and 42'. Yet another
17 90-degree rotation results in adaptor interface 26'' being active with contacts 36'', 38'',
18 40'', and 42''. Finally, a last 90-degree rotation results in adaptor interface 26''' being
19 active using contacts 36''', 38''', 40''', and 42''' to interface with the peripheral
20 interface 28.

21 With reference to Figure 3b, an exemplary 13-pin custom contact assignment
22 matrix used to couple the adaptor with a similar 13-socket peripheral interface. The
23 sockets are configured to receive the pins and electrically and mechanically couple the
24 peripheral to the USB orientation adaptor. Specifically, the 13-pin custom contact

1 assignment matrix illustrates how the USB input contacts 15, 17, 19, and 21 are
2 replicated and connected to contacts A 36, B 38, C 40, and D 42 respectively in the
3 contact assignment matrix. This configuration utilizes a central contact D 42 in all four
4 orientations, thereby minimizing the cost and degree of difficulty associated with
5 construction of the adaptor. As with the previous interface, the interface illustrated in
6 Figure 3b is wired in such a way so as to ensure the proper connection of the four USB
7 signal lines in each of the possible orientations of the adaptor interface. The active
8 contacts for each orientation are grouped together. For example, if adaptor 24 is properly
9 oriented then adaptor interface 26 includes the active contacts 36, 38, 40, and 42. When
10 the adaptor is rotated 90-degrees the active adaptor interface is 26' includes contacts 36',
11 38', 40', and 42'. In this embodiment, contact point D42 is reused with each orientation.
12 Yet another 90-degree rotation results in adaptor interface 26'' being active with contacts
13 36'', 38'', 40'', and 42''. Finally, a last 90-degree rotation results in adaptor interface
14 26''' being active using contacts 36''', 38''', 40''', and 42''' to interface with the
15 peripheral interface 28.

16 With reference to Figure 3c, another exemplary 13-pin custom contact assignment
17 matrix used to couple the USB adaptor with a similar 13-socket peripheral interface. As
18 with the previous interfaces, the interface illustrated in Figure 3c is wired in such a way
19 so as to ensure the proper connection of the four USB signal lines in each of the possible
20 orientations of the adaptor interface. In get and other variation to this embodiment, this
21 interface utilizes a large central contact D 42 that may be used as a guidepost to assist the
22 user in coupling the adaptor and peripheral in each of the orientations. This guidepost is
23 larger than the other contacts, making the insertion of the plug into the socket easier. The
24 rounded nature of the guidepost allows for insertion assistance without committing the

1 coupling to one particular orientation. In an alternative configuration the central
2 guidepost may be shaped to preclude insertion except in one of the specified orientations.
3 For example, a square guidepost would limit insertion to one of four preferred
4 orientations, while a hexagon guidepost would limit insertion to one of six preferred
5 orientations.

6 With reference to Figure 3d, another exemplary 13-pin custom contact assignment
7 matrix used to couple the adaptor with a similar 13-socket peripheral interface. This
8 interface utilizes a central contact surrounded by three sets of concentric contact rings
9 comprising multiple contact points. The contact points on each concentric contact ring
10 may be arranged according to the desired orientations of the plug and socket. Figure 3d
11 illustrates four possible orientations using USB contact groupings 26, 26', 26'', and 26'''
12 where the center contact point D 42 is reused with each orientation. Also, the positional
13 location of each contact A 36, B 38, C 40, and D 42 may be interchanged with other
14 positions without departing from the scope of the invention. As with the previous
15 interface, the interface illustrated in Figure 3d is wired in such a way so as to ensure the
16 proper connection of the four USB signal lines in each of the possible orientations of the
17 adaptor interface.

18 Figure 3e provides a perspective view of the pin or socket configuration
19 illustrated in 3d. One advantage of this configuration is that it minimizes the
20 manufacturing costs and the size of the custom adaptor. For example, each contact ring
21 may be manufactured using a single stamp and the adaptor may be configured so that the
22 connections do not have to cross each other, where the contacts could short. The metal
23 stamp would resemble a hub with spokes, where each spoke may be bent accordingly to
24 become the contact points for the USB and custom interface sides. This physical

1 orientation is also advantageous in that the separation between rings need only be radially
2 constant allowing the overall size of the plug and socket to be smaller than in many other
3 illustrated configurations. In an alternative configuration, the concentric arrangement
4 could also utilize a center guidepost to direct and assist the plug and socket coupling.

5 The contact configuration shown in Figures 3, 5, and 6^{are} only examples of
6 acceptable adaptor interfaces. As is known to one skilled in the art, this particular contact
7 orientation is not the only configuration that might be used. In fact, any orientation,
8 which allows the peripheral to be rotated to the four different orientations, would be
9 acceptable. Furthermore, multiple orientations are possible by expanding the adaptor and
10 peripheral interface to include a section of contacts for each desired orientation. Also the
11 number of contacts may be increased. While the preferred embodiment utilizes the USB
12 standard with four contacts, other standards may require more contacts. Yet another
13 configuration realizes the ability to generate a suitable orienting connector that shares a
14 centralized contact in every possible orientation. Other similar configurations are
15 considered to be within the scope of the present invention.

16 Figure 4 is a perspective view of a rotating adaptor using a circular contact
17 coupling for rigidly affixing a digital device and peripheral together. The circular contact
18 coupling 26 is useful for interfaces where the desired orientation of the peripheral is
19 unspecified or the peripheral device needs to continuously reorient relative to the digital
20 device. The illustrated rotating adaptor 25 includes a USB series "A" plug 22 electrically
21 coupled to a USB series "B" plug 44 via circular contact coupling 26. The circular
22 coupling on the adaptor between the digital device and the peripheral electrically
23 connects the devices without limiting the mechanical coupling to a specific orientation.
24 A specific circular contact coupling is illustrated and described in more detail in Figure 5.

1 The USB series "A" plug contacts 15, 17, 19, and 21 (Figure 1) are electrically
2 coupled to USB series "B" plug contacts 45, 47, 49, and 51. The series "B" plug is
3 adapted to mechanically and electrically couple with series "B" receptacle 46. When
4 properly coupled contacts 45, 47, 49, and 51 of the plug electrically couple with contacts
5 55, 57, 59, and 61 of the receptacle according to USB specifications. An alternative
6 configuration mechanically couples the series "B" plug and receptacle in a manner that
7 requires a greater extraction force to break the coupling than is required by the coupling
8 between the series "A" plug and receptacle. This ensures that the rotating adaptor will
9 remain attached to the peripheral upon removal of the adaptor from the attached digital
10 device. Yet another configuration uses custom couplings between the rotating adaptor
11 and the peripheral or the digital device that still allows for the rotational reorientation
12 between the peripheral and the digital device via the adaptor.

13 Figure 5 illustrates a custom connector contact assignment interface for use with
14 the circular contact connector interface as illustrated in Figure 4. The USB signals are
15 extended from the plug to the adaptor interface such that the outer contact ring 66 is
16 electrically connected to VBUS signal 15. D- signal 17 is electrically connected to
17 contact ring 68. D+ signal 19 is electrically connected to contact ring 70. Finally, GND
18 signal 21 from the USB connector plug is electrically connected to the center contact 72.
19 The circular contact coupling 26 may use a variety of contact means to transfer the
20 signals to the output lines on the series "B" plug 45, 47, 49, and 51. For example, the
21 rotating adaptor may use capacitive, inductive, or direct connections, such as wire
22 brushes, to engage each contact ring and relay the signals to the peripheral device via the
23 plug regardless of the orientation.

24

1 Variations of the circular contact connector interface include variable circular
2 contacts in which the electrical contact rings 66, 68, and 70 are only electrically engaged
3 at predetermined positions relative to peripheral device orientations and disengaged or
4 disabled between the predetermined positions. Another configuration uses a continuous
5 electrical connection with slotted mechanical orientations so that the circular contact
6 coupling clicks into each of the mechanical orientations.

7 One of these concentric variations is illustrated in Figure 6. Each contact ring A,
8 B, C, and D ^{is} ~~are~~ separated via insulated sections between each contact. The contact rings
9 are concentric around an axis. The contact rings may have smooth or staggered radii.
10 Staggered radii allow for simultaneous contact by the socket contacts 76, 78, 80, and 82.
11 As illustrated in Figure 6, the socket contacts are also oriented so that only socket contact
12 82 can electrically couple to contact tip D. Each of the contact points may be
13 interchanged, but the USB contact can only be made if the plug is fully inserted in the
14 socket. Furthermore, the diameters of each contact may vary such as in an increasing
15 diameter at the proximal end of the series of contact sockets.

16 The present invention may be embodied in other specific forms without departing
17 from its spirit or essential characteristics. The described embodiments are to be
18 considered in all respects only as illustrative and not restrictive. The scope of the
19 invention is, therefore, indicated by the appended claims rather than by the foregoing
20 description. All changes that come within the meaning and range of equivalency of the
21 claims are to be embraced within their scope.

22 What is claimed and desired to be secured by United States Letters Patent is:
23
24